MASTERDRAIN
The alternative drainage design software
http://www.mstdrain.co.uk.

Seawinds, Carpenters Lane, Brook,
Newport, Isle of Wight PO30 4EU
email: sales@mstdrain.co.uk
Tel: 01983 740064

Job No.	Sheet no.	Date
1234/2010	1	24/09/10

Project	By	Checked	Approved

MasterDrain SW

Title: **Hydrograph storage calcs (Summer profile) for BECKENHAM**

Data:-

Hydrology:-

Grid reference = TQ3769 Location = BECKENHAM
M5-60 (mm) = 20 r = 0.41
WRAP/Soil = 1 / 0.15 SAAR (mm/yr) = 660
Return period = 100 Mean intensity = 8.4mm/hr for a 10.88 hour storm
Climate change factor = 30%

Percentage runoff = 100.0% (manual setting)

Imperv. area = 15175 m² Pervious area = 0 m²
Total area = 15175 m² Equiv area = 15175 m² (Tot. area x % runoff).
Total runoff = 1378.6 m³ Discharge rate = 5.00 l/s
Storage (m³) = 1184.0 m³ (Sum of all balance quantities)
Total rainfall depth = 90.8 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.109	32.0	2.7	4.415	1.960	2.455	2.455
0.218	33.0	2.8	4.553	1.960	2.593	5.048
0.326	33.0	2.8	4.553	1.960	2.593	7.642
0.435	34.0	2.8	4.691	1.960	2.731	10.373
0.544	34.0	2.8	4.691	1.960	2.731	13.104
0.653	35.0	2.9	4.829	1.960	2.869	15.973
0.762	35.0	2.9	4.829	1.960	2.869	18.842
0.870	36.0	3.0	4.967	1.960	3.007	21.849
0.979	36.0	3.0	4.967	1.960	3.007	24.856
1.088	37.0	3.1	5.105	1.960	3.145	28.001
1.197	37.0	3.1	5.105	1.960	3.145	31.146
1.306	38.0	3.2	5.243	1.960	3.283	34.429
1.414	38.0	3.2	5.243	1.960	3.283	37.712
1.523	39.0	3.3	5.381	1.960	3.421	41.133
1.632	40.0	3.3	5.519	1.960	3.559	44.692
1.741	42.0	3.5	5.795	1.960	3.835	48.527
1.850	42.0	3.5	5.795	1.960	3.835	52.362
1.958	43.0	3.6	5.933	1.960	3.973	56.335
2.067	44.0	3.7	6.071	1.960	4.111	60.446
2.176	45.0	3.8	6.209	1.960	4.249	64.695
2.285	46.0	3.8	6.347	1.960	4.387	69.082
2.394	48.0	4.0	6.623	1.960	4.663	73.745
2.502	49.0	4.1	6.761	1.960	4.801	78.545
2.611	51.0	4.3	7.037	1.960	5.077	83.622
2.720	52.0	4.3	7.175	1.960	5.215	88.837
2.829	54.0	4.5	7.451	1.960	5.491	94.327
2.938	56.0	4.7	7.727	1.960	5.767	100.094
3.046	58.0	4.8	8.003	1.960	6.043	106.137
3.155	61.0	5.1	8.416	1.960	6.456	112.593
3.264	64.0	5.3	8.830	1.960	6.870	119.463
3.373	68.0	5.7	9.382	1.960	7.422	126.886
3.482	72.0	6.0	9.934	1.960	7.974	134.860
3.590	78.0	6.5	10.762	1.960	8.802	143.662
3.699	84.0	7.0	11.590	1.960	9.630	153.292
3.808	91.0	7.6	12.556	1.960	10.596	163.888
3.917	99.0	8.3	13.660	1.960	11.700	175.587
4.026	110.0	9.2	15.177	1.960	13.217	188.804
4.134	123.0	10.3	16.971	1.960	15.011	203.815
4.243	136.0	11.4	18.765	1.960	16.805	220.620
4.352	152.0	12.7	20.972	1.960	19.012	239.632
4.461	170.0	14.2	23.456	1.960	21.496	261.128
4.570	188.0	15.7	25.939	1.960	23.979	285.107
4.678	208.0	17.4	28.699	1.960	26.739	311.846

Seawinds, Carpenters Lane, Brook,
Newport, Isle of Wight PO30 4EU
email: sales@mstdrain.co.uk
Tel: 01983 740064

Job No.	Sheet no.	Date	By	Checked	Approved
1234/2010	2	24/09/10			

Project

Title **Hydrograph storage calcs (Summer profile) for BECKENHAM**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
4.787	228.0	19.0	31.458	1.960	29.498	341.344
4.896	250.0	20.9	34.494	1.960	32.534	373.878
5.005	274.0	22.9	37.805	1.960	35.845	409.723
5.114	300.0	25.1	41.392	1.960	39.432	449.155
5.222	328.0	27.4	45.256	1.960	43.296	492.451
5.331	358.0	29.9	49.395	1.960	47.435	539.886
5.440	392.0	32.7	54.086	1.960	52.126	592.012
5.549	392.0	32.7	54.086	1.960	52.126	644.138
5.658	358.0	29.9	49.395	1.960	47.435	691.573
5.766	328.0	27.4	45.256	1.960	43.296	734.869
5.875	300.0	25.1	41.392	1.960	39.432	774.301
5.984	274.0	22.9	37.805	1.960	35.845	810.146
6.093	250.0	20.9	34.494	1.960	32.534	842.680
6.202	228.0	19.0	31.458	1.960	29.498	872.178
6.310	208.0	17.4	28.699	1.960	26.739	898.917
6.419	188.0	15.7	25.939	1.960	23.979	922.896
6.528	170.0	14.2	23.456	1.960	21.496	944.392
6.637	152.0	12.7	20.972	1.960	19.012	963.404
6.746	136.0	11.4	18.765	1.960	16.805	980.209
6.854	123.0	10.3	16.971	1.960	15.011	995.220
6.963	110.0	9.2	15.177	1.960	13.217	1008.437
7.072	99.0	8.3	13.660	1.960	11.700	1020.136
7.181	91.0	7.6	12.556	1.960	10.596	1030.732
7.290	84.0	7.0	11.590	1.960	9.630	1040.362
7.398	78.0	6.5	10.762	1.960	8.802	1049.164
7.507	72.0	6.0	9.934	1.960	7.974	1057.138
7.616	68.0	5.7	9.382	1.960	7.422	1064.560
7.725	64.0	5.3	8.830	1.960	6.870	1071.431
7.834	61.0	5.1	8.416	1.960	6.456	1077.887
7.942	58.0	4.8	8.003	1.960	6.043	1083.930
8.051	56.0	4.7	7.727	1.960	5.767	1089.696
8.160	54.0	4.5	7.451	1.960	5.491	1095.187
8.269	52.0	4.3	7.175	1.960	5.215	1100.402
8.378	51.0	4.3	7.037	1.960	5.077	1105.478
8.486	49.0	4.1	6.761	1.960	4.801	1110.279
8.595	48.0	4.0	6.623	1.960	4.663	1114.942
8.704	46.0	3.8	6.347	1.960	4.387	1119.329
8.813	45.0	3.8	6.209	1.960	4.249	1123.578
8.922	44.0	3.7	6.071	1.960	4.111	1127.688
9.030	43.0	3.6	5.933	1.960	3.973	1131.661
9.139	42.0	3.5	5.795	1.960	3.835	1135.496
9.248	42.0	3.5	5.795	1.960	3.835	1139.331
9.357	40.0	3.3	5.519	1.960	3.559	1142.890
9.466	39.0	3.3	5.381	1.960	3.421	1146.311
9.574	38.0	3.2	5.243	1.960	3.283	1149.594
9.683	38.0	3.2	5.243	1.960	3.283	1152.877
9.792	37.0	3.1	5.105	1.960	3.145	1156.022
9.901	37.0	3.1	5.105	1.960	3.145	1159.167
10.010	36.0	3.0	4.967	1.960	3.007	1162.175
10.118	36.0	3.0	4.967	1.960	3.007	1165.182
10.227	35.0	2.9	4.829	1.960	2.869	1168.051
10.336	35.0	2.9	4.829	1.960	2.869	1170.920
10.445	34.0	2.8	4.691	1.960	2.731	1173.651
10.554	34.0	2.8	4.691	1.960	2.731	1176.382
10.662	33.0	2.8	4.553	1.960	2.593	1178.975
10.771	33.0	2.8	4.553	1.960	2.593	1181.569
10.880	32.0	2.7	4.415	1.960	2.455	1184.024

Storage volume (m^3) = 1184.0 m^3 (Sum of all balance quantities)

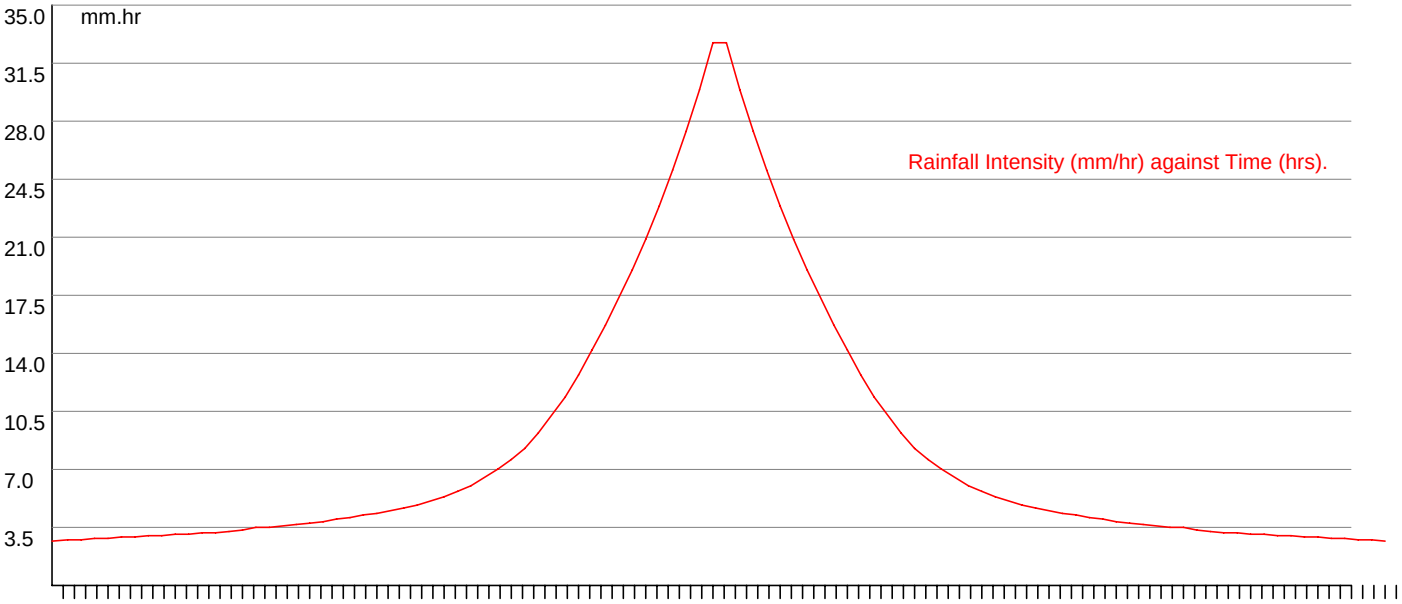
MASTERDRAIN
The alternative drainage design software
http://www.mstdrain.co.uk.
Seawinds, Carpenters Lane, Brook,
Newport, Isle of Wight PO30 4EU
email: sales@mstdrain.co.uk
Tel: 01983 740064

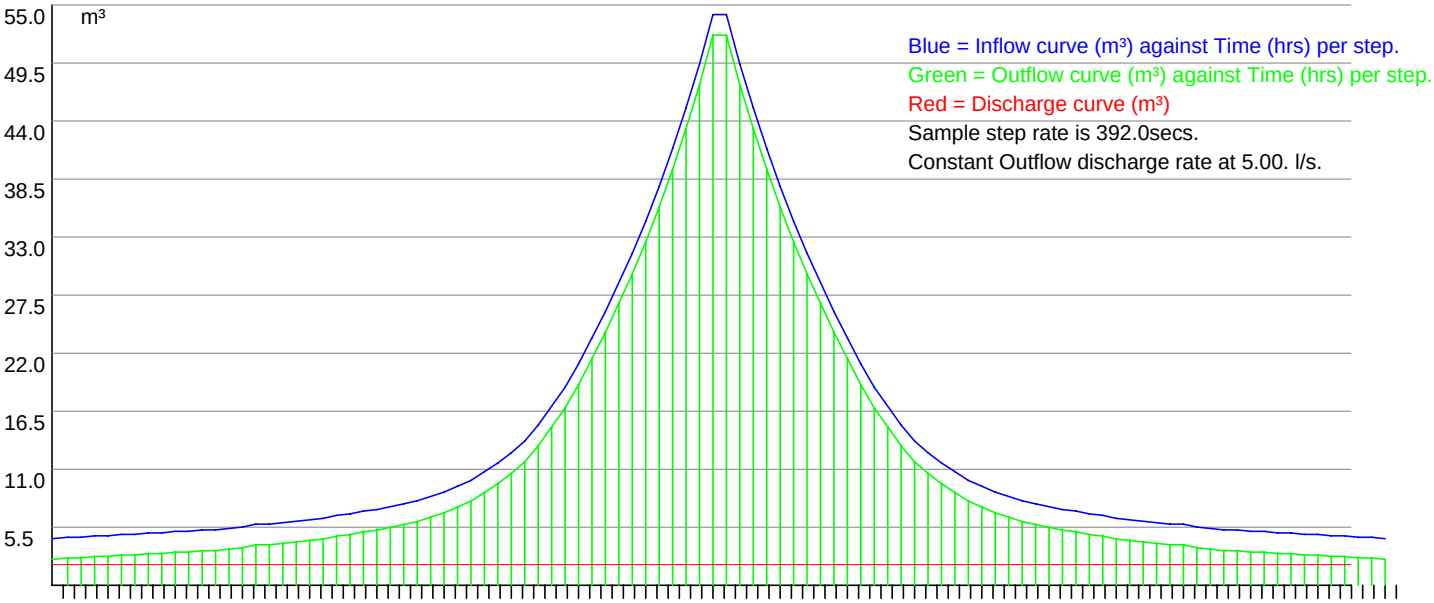
MasterDrain SW

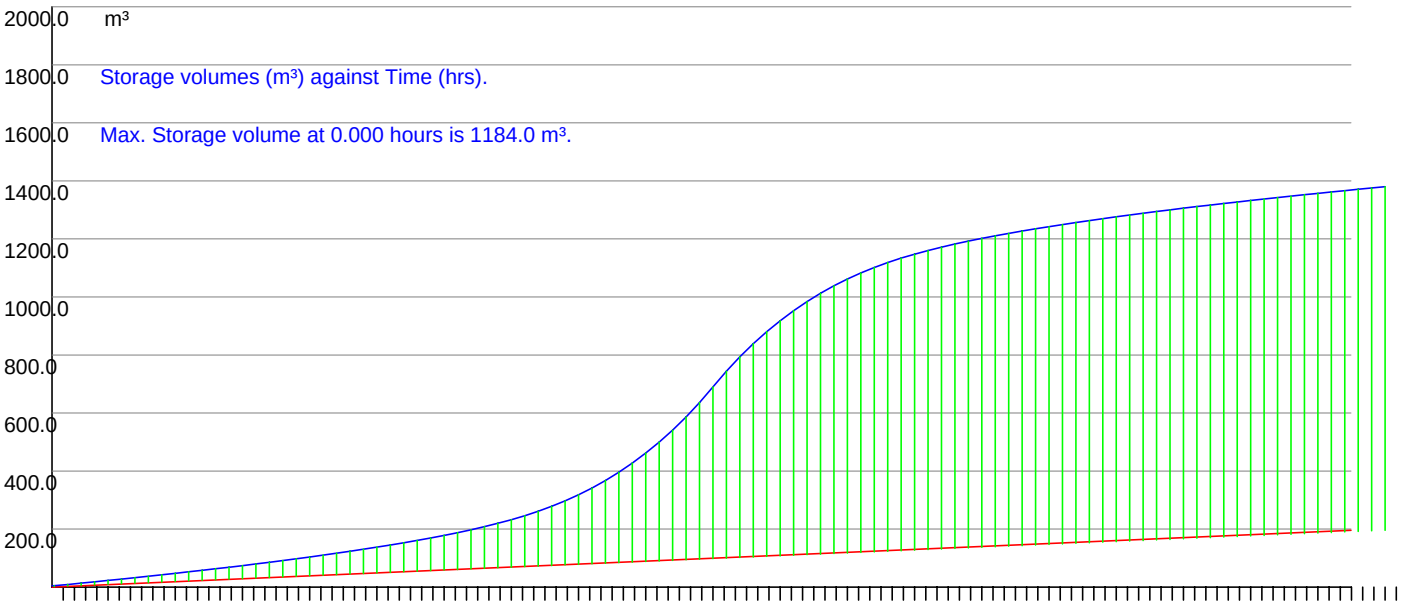
Job No.	Sheet no.	Date
1234/2010	3	24/09/10

Project	By	Checked	Approved

Title: **Hydrograph storage calcs (Summer profile) for BECKENHAM**







Seawinds, Carpenters Lane, Brook,
Newport, Isle of Wight PO30 4EU
email: sales@mstdrain.co.uk
Tel: 01983 740064

Job No.	Sheet no.	Date
1234/2010	4	24/09/10

Project	By	Checked	Approved

Title **Hydrograph storage calcs (Summer profile) for BECKENHAM**

Explanatory notes for Peak Flow Storage

1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
2) The outflow is regarded as constant for the duration of the storm; i.e. no allowance is made for the changing head behind the flow restrictor.*
3) The balance is calculated from the inflow minus the outflow.
4) The storage volume is the maximum value of the balance curve.
5) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
6) References to 'storm duration' relate only to the hydrograph method (qv).
7) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

1) The user has the choice of Summer or Winter curves
2) The mean intensity varies with the duration of the storm curve
3) There are always 120 steps in the calculation process, irrespective of storm duration.
4) The outflow is regarded as constant for the duration of the storm; i.e. no allowance is made for the changing head behind the flow restrictor.*
5) The balance is calculated from the inflow minus the outflow.
6) The storage volume is the sum of the balance values for each step.
7) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.